LAI Lean Product Development Research

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LAI Enterprise Lean Product Development Research Overview

Fundamental research questions in this area:

- "How far and how directly can lean principles developed for production operation be applied to product development?"
- With enterprise focus: "How can lean principles be applied to help enterprises develop and manage resources and capabilities to efficiently create streams of successful products?"
- Enterprise perspective includes:
  - Multiple functions, from enterprise strategy through development, production, distribution, and support of products
  - Many products, probably concurrently and possibly as part of a larger grouping of products in a family or system of systems

Priorities for LAI Enterprise Lean Product Development Research

- Identifying the design of **enterprise structures and processes** that enable high performance in decision-making and risk/uncertainty reduction.
- Understanding the interactions between **enterprise and product architectures** in complex systems and systems-of-systems to enable higher PD productivity from enterprise resources.
- Characterizing and identifying processes for increasing the value of the product/enterprise portfolio, focusing primarily on activities that **reduce risk/uncertainty for decision-makers**.
- Characterizing successful **implementation, execution, and transformation** of lean PD processes in complex PD environments.

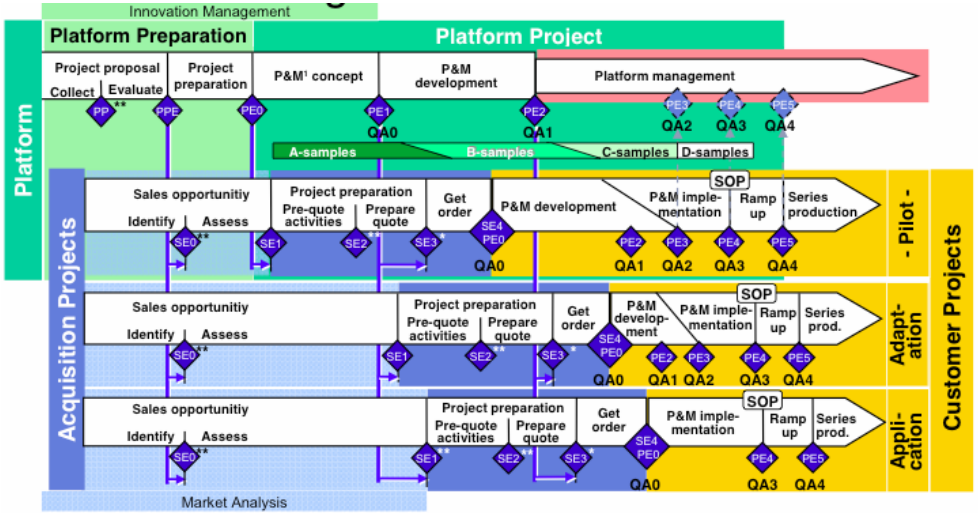
Process Commonality in Enterprise Product Development

Researcher: Sidharth Rupani (Advisor: Warren Seering)

Completion: ESD PhD, May 2009

Motivation:

Product architectures using platforms, modularity, and reuse produce significant savings in the creation of new product derivatives. This research explores using similar concepts to organizational process design to understand the potential benefits of both standard and variant processes across business units and projects in an enterprise and the development of more effective learning organizations.



Synopsis:

This research will study existing enterprise PD processes from several divisions and projects of 3-5 organizations to answer the question "What is the right level of process commonality and how should it be managed?" Models and methods selected from the product platforms literature will be used to analyze the processes. The goal is to consider the effects of process standardization and diversity and create a framework to help manage the tradeoffs.

Outcomes:

1. Case studies of several enterprise process architectures, with primary focus on enterprise product development processes
2. Heuristics for creating enterprise processes and determining appropriate levels of commonality
3. Insights into enterprise process design, metrics, and methods
4. Doctoral dissertation June 2009, papers

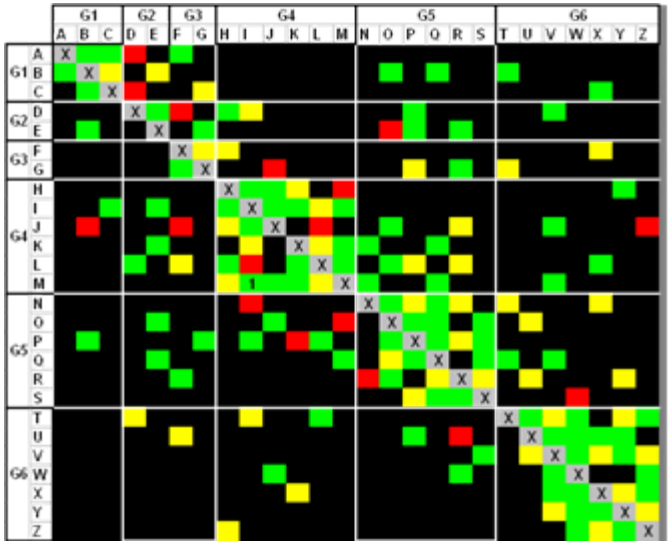
Alignment of Actors in Complex Product Development

Researcher: Joao Castro (Advisor: Warren Seering)

Completion: ESD PhD, May 2009

Motivation:

Alignment and coordination of actors and activities in complex enterprise PD systems is critical to achieving high performance. Past LAI research has identified significant wastes in PD processes resulting from poor alignment, and studies of high performance PD enterprises such as Toyota indicate a high priority placed on aligning people and processes.



Synopsis:

This research seeks to understand, measure and represent alignment in multi-disciplinary PD organizations. It will develop a method for assessing alignment, and identify any causal connections between alignment state, alignment-promoting methods and team performance. It will use case studies of PD efforts coupled with interviews and surveys of the participants to determine the extent to which interactions are required, implementable and executed correctly.

Outcomes:

1. Management tools to assess state and act on alignment (e.g., Information Dashboard)
2. Heuristics on usefulness of different coordination and alignment methods at the system level to improve the efficiency and throughput of Product Development process
3. Doctoral Thesis, May 2009
4. Conference presentations and Journal papers

Globally vs. Locally Distributed Product Development

Researcher: Pedzi Makumbe (Advisor: Warren Seering)

Completion: ESD PhD, May 2008

Motivation:

Products are increasingly being developed globally, with many citing benefits such as lower cost and shorter cycle time. This study will attempt to quantify both costs and benefits of global product development to assess what benefit, if any is gained, and where potential challenges for execution may lie

Global Product Development:

An observed phenomenon

e.g. Boeing 787

e.g. Camry 2007

e.g. Fusion 2007

Synopsis:

This study will use paired case studies of development programs drawn from large companies developing complex engineered systems to quantify the benefits and penalties associated with global PD (including labor arbitrage, coordination penalty, performance and cycle time), as well as the implications for global PD enterprise design (product development strategy, lateral processes, people capabilities and culture, and reward systems.)

Outcomes:

1. Quantified benefits and costs associated with developing selected products globally vs. locally
2. Summary of management practices associated with successful global product development
3. Doctoral dissertation June 2008
4. Conference papers

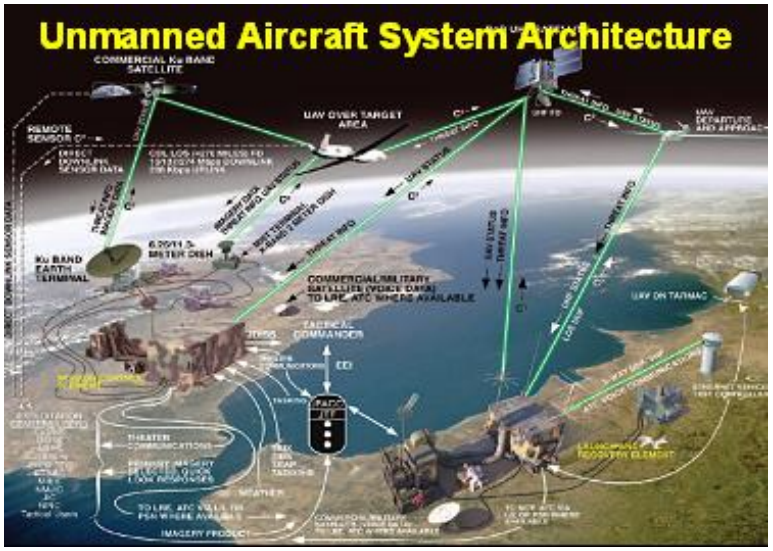
Understanding the Role of Modularity in Complex Defense Systems

Researcher: Lt Col Dave Long (USAF) (Advisor: Warren Seering)

Completion: ESD PhD, May 2008

Motivation:

DoD investment in unmanned aircraft systems (UASs) is increasing tenfold in this decade, but lack of coordination across platforms and cost and schedule growth are a concern. Many PD organizations use modular product architecture to successfully manage the development of families of products. This research will characterize the benefits of adopting a modular architecture strategy to acquire UASs.



Synopsis:

The system architectures of representative fielded UASs will be captured and modeled. The architectures will be analyzed to identify elements that lend themselves to modularization and product family strategies. The organizational systems that produce, manage, and operate these systems will also be analyzed to assess barriers to adopting and executing a modular architecture strategy.

Outcomes:

- Best practices and architectures for Mission Control Element modularity
- Enterprise designs that facilitate the execution of modular product architectures across systems of systems
- Expand existing theory to apply platform optimization methods to government acquisition projects
- Doctoral thesis June 2008, papers

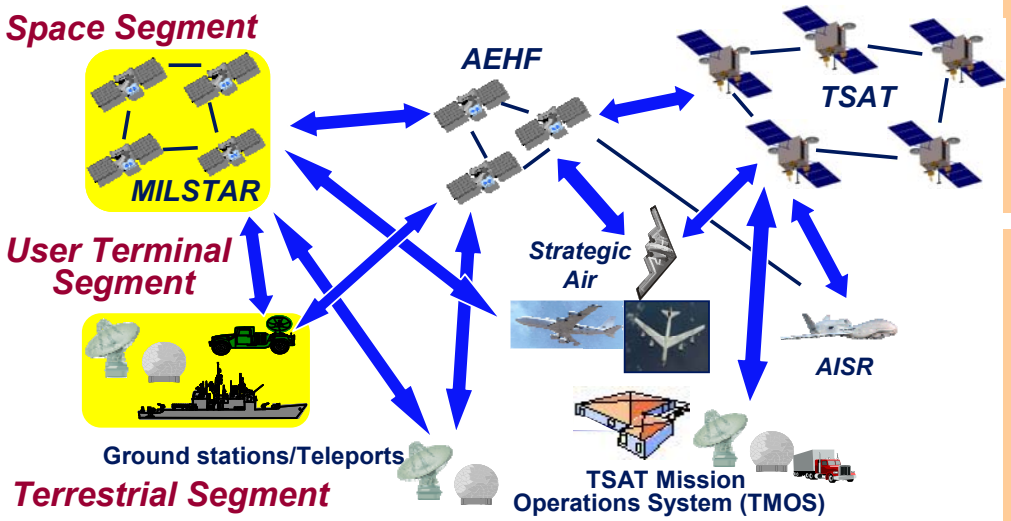
Synchronization of System-of-Systems Interfaces in MILSATCOMs

Researcher: Maj Mark Davis (USAF) (Advisor: Eric Rebentisch)

Completion: SDM SM, Jan 2008

Motivation:

Military satellite communications programs have grown from distinct satellite constellations with dedicated terrestrial terminals to multiple constellations and dozens of multi-purpose terminal variants with system interfaces that span the boundaries of large systems of systems. Unsynchronized interface requirements have caused significant scrap and rework in the design and development of the new satellites and terminals, leading to adverse impacts including large cost growth and schedule delays.



Synopsis:

This research will use review of contracts and interface documentation, participation in interface management meetings, and interviews with program personnel to quantify the cost and schedule impact of unsynchronized satellite communication system-of-systems interfaces, understand what change management processes are in place to synchronize system-of-systems interfaces, and characterize best practices including lean principles to be applied to improve system-of-systems interface synchronization. The focus will be on Air Force communications satellites and their external interfaces.

Outcomes:

1. Characterize cost and schedule impact of unsynchronized interface requirements
2. Best practices to for interface management and process improvement
3. Master's thesis, Jan 2008

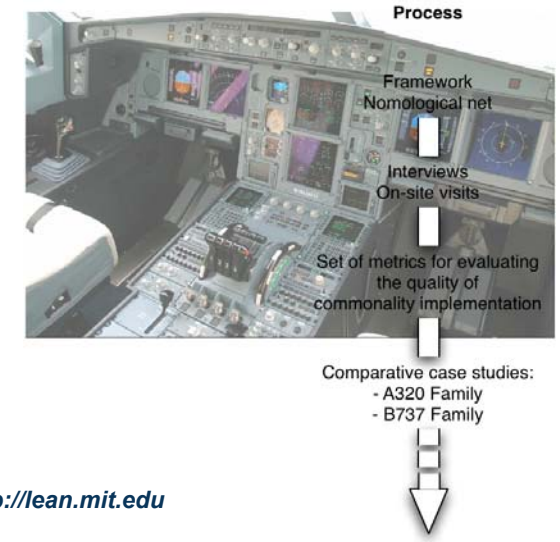
Measuring The Efficiency Of Commonality in Commercial Aircraft Cockpits

Researcher: Damien Bador (Advisor: Warren Seering)

Completion: SM, May 2007

Motivation:

Increasing commonality across their models allows commercial aircraft manufacturers to reduce the product development cycle time and tailor their models to their customers' needs. The cockpit is an area where commonality is thought to be particularly desirable, since it also simplifies the pilot's training process for customers. However, no set of metrics is currently able to measure the efficiency of commonality application at this level from a total lifecycle standpoint.



Synopsis:

This research uses interviews with enterprise stakeholders and the analysis of several cockpit architectures from 2 families of commercial aircraft. Using this data and building on prior research, it proposes a set of metrics adapted to large commercial aircraft and taking into account the main parts of the product lifecycle. It will address the optimal level of commonality across different platforms.

Outcomes:

1. Set of metrics to assess the effects of cockpit commonality across product platforms
2. Master's thesis, May 2007
3. ICED 2007 paper, LAI conference paper

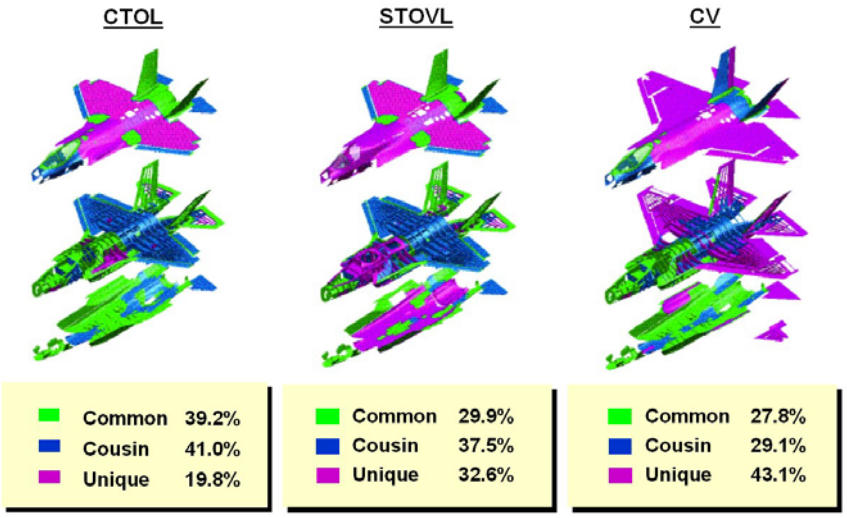
Managing Commonality During Product Family Development

Researcher: Ryan Boas (Advisor: Ed Crawley)

Completion: ESD PhD, May 2007

Motivation:

Commonality (i.e., sharing parts, processes, interfaces and infrastructure) across a product family offers the potential for overall product family cost, lead and risk reductions. Strong industrial interest in commonality coupled with incomplete knowledge about its application has created rich opportunities for collaborative research between industry and academia. Improved management of commonality offers a path to increased enterprise profitability.



Synopsis:

This research will use a combination of case studies, modeling, and theory to differentiate between parallel and sequential development of product families. It will define the causes of and impacts associated with evolving (and diverging) commonality strategies, and propose mitigations where applicable. It will model the economic benefits and penalties of commonality.

Outcomes:

1. Heuristics to manage commonality across multiple products in a family.
2. Doctoral thesis, May 2007, papers

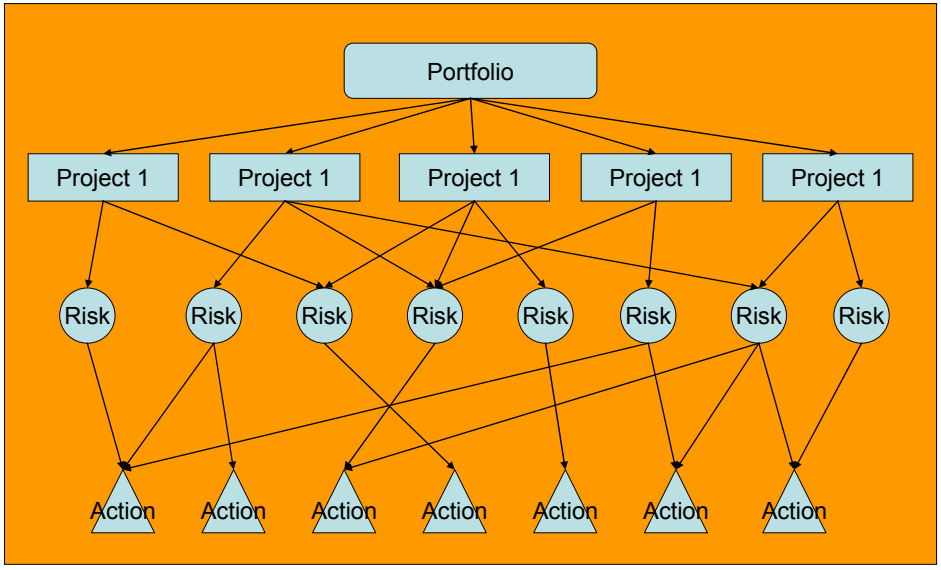
Enterprise Portfolio Management and Risk Aggregation

Researcher: Maj Robb Wirthlin (USAF) (Advisor: Warren Seering)

Completion: ESD PhD, May 2008

Motivation:

Few product development (PD) enterprises consistently create new products on time and on schedule. This research explores how risk management at the portfolio level may help enterprises to manage their entire PD value stream more effectively. It will develop metrics for assessing and aggregating enterprise level PD risk.



Synopsis:

This research will use a combination of interviews with portfolio managers, case studies of enterprise risk management, and simulation modeling of PD portfolios to develop metrics and methods for assessing risk at the portfolio level. Field research will identify methods and best practices for managing risk at the portfolio level. The methods will be validated by application to an existing PD portfolio.

Outcomes:

1. Measures of risk and procedures useful at the enterprise/product portfolio level
2. Heuristics and practices for managing risks at the enterprise level in PD
3. Demonstration of applicability of metrics and practices to an existing product development portfolio
4. Doctoral dissertation June 2008
5. Conference and Journal papers

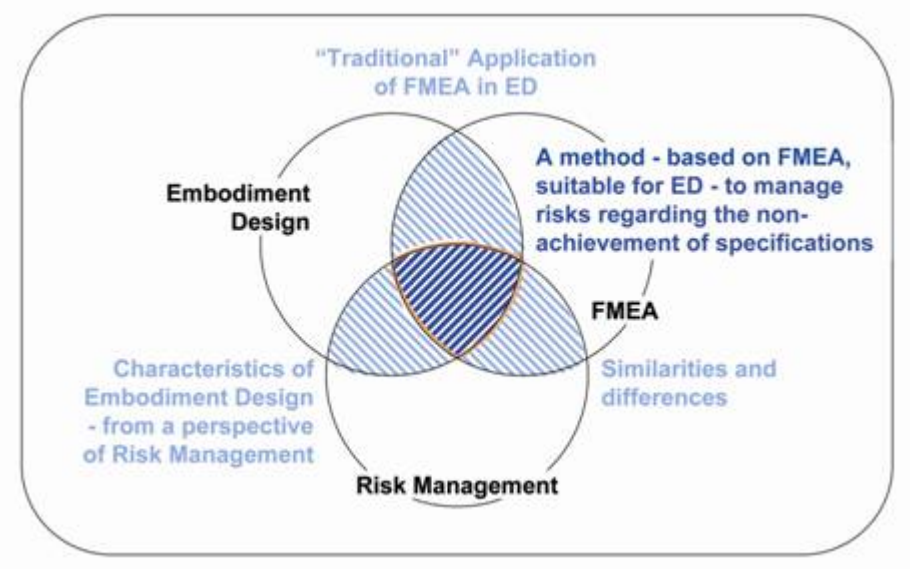
An FMEA-based Method for Risk Management in Embodiment Design

Researcher: Claudia Wagner (Advisor: Warren Seering)

Completion: TUM Dipl. Thesis May 2007

Motivation:

Effectively managing risk in new product development significantly reduces the likelihood of cost, schedule, and performance deviations during execution. Many risks inherent in a product are defined with its architecture. This research will investigate a method to assess and manage risks during the product architecting phase



Synopsis:

This research investigates the application of the FMEA method to product architecting. It will assess the effectiveness of by comparing its application in multiple teams in a MIT product design course. It will use a combination of surveys, interviews, structured methods, and direct observation for data collection.

Outcomes:

1. Development and Application of FMEA method to manage product risks during product architecting
2. Diploma Thesis (TUM), May 2007

Identifying Needs for New Air Force Aircraft

Researcher: Lt Col Dan Gillespie (USAF) (Advisor: Warren Seering)

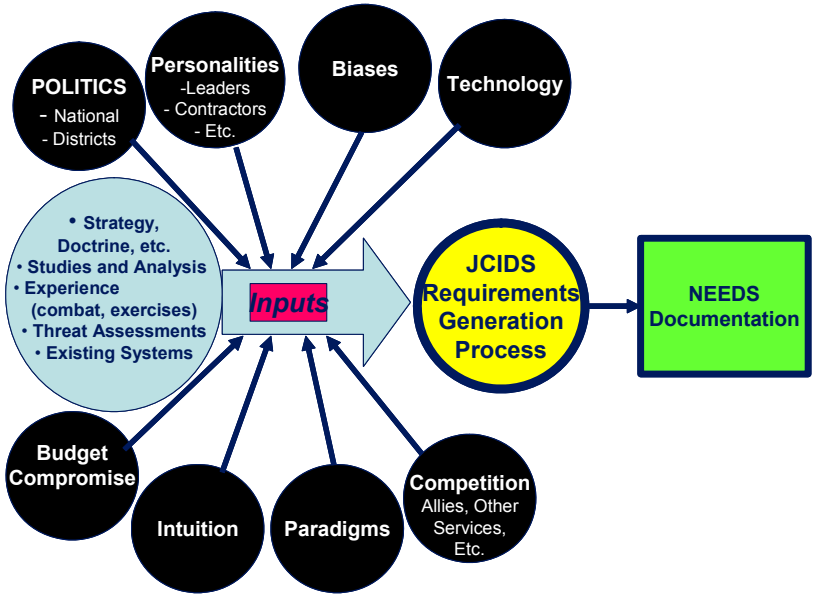
Completion: ESD PhD, May 2009

Motivation:

The identification of needs for new USAF aircraft exhibits evidence of numerous inputs which are not formalized in the current process. While the goal is to meet an identified operational need, political, economic, cultural and other factors influence the definition of needs. This research seeks to understand mechanisms by which useful inputs and detrimental inputs can be identified as such.

Synopsis:

This research will use historical case studies to identify the inputs to the processes used to define needed capabilities, with emphasis on decision-making processes, analyses, and stakeholder participation. Case studies will be drawn primarily from USAF systems, although some comparative cases from other domains may be used.



Outcomes:

1. Best practices in needs identification, including enterprise processes that are more successful in producing needs expressed in terms of capabilities.
2. Doctoral thesis, June 2009, papers

Lean Product Development Transformation Case Studies

Researcher: Eric Rebentisch

Completion: Fall 2007

Motivation:

High-performance product development system principles have been well-documented for some time, but evidence of their implementation into consistent practice is limited (resulting in a "knowing-doing gap".) Increasingly, Toyota PD principles are also documented, but not widely used outside Toyota and its closest suppliers. Findings suggest that leadership, organizational, and culture factors play a critical role in the development of these consistently high-performing systems. Yet, the PD literature addresses primarily "to-be" states rather than the "transforming to" or the "managing" aspects of PD enterprises.

Synopsis:

This research will document the transformation journeys of PD organizations that have demonstrated consistent, pervasive improvement over several years. It will use direct observations and interviews with enterprise stakeholders to identify factors in the successful transformation of enterprise PD capabilities and culture.

Outcomes:

1. Case studies
2. Fall 2007 completion
3. Companion to LAI enterprise transformation case studies
4. Content for a Lean PD book

